U.S. Army Research Institute
for the Behavioral and Social Sciences

Research Report 1822

Instructional Characteristics and Motivational Features of a PC-based Game

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April 2004

20040514 066

U.S. Army Research Institute
for the Behavioral and Social Sciences

A Directorate of the U.S. Army Human Resources Command

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REPORT DOCUMENTATION PAGE

1. REPORT DATE (dd-mm-yy)	2. REPORT TYPE	3. DATES COVERED (from. . . to)
April 2004	Final	January 2003 – January 2004

4. TITLE AND SUBTITLE Instructional Characteristics and Motivational Features of a PC-based Game	5a. CONTRACT OR GRANT NUMBER 5b. PROGRAM ELEMENT NUMBER: 633007
6. AUTHOR(S) James Belanich (U.S. Army Research Institute for the Behavioral and Social Sciences), Daragh E. Sibley, and Kara L. Orvis (George Mason University)	5c. PROJECT NUMBER: A792 5d. TASK NUMBER: 214 5e. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences Advanced Training Methods Research Unit 5001 Eisenhower Avenue Alexandria, VA 22304-4841	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Research Institute for the Behavioral and Social Sciences Attn: DAPE-ARI-II 5001 Eisenhower Avenue Alexandria, VA 22304-4841	10. MONITOR ACRONYM ARI 11. MONITOR REPORT NUMBER Research Report 1822

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 words)*:

The purpose of the research was to identify and assess instructional and motivational features of a first-person-perspective game environment. The game used was “America’s Army”, a popular PC-based game developed by the U.S. Army to inform “recruiting age” individuals about the Army. Twenty-one participants first completed a pre-game questionnaire that assessed prior knowledge of information presented in the game, after which they played the “basic training” sections of the game. Then, participants answered questions regarding information presented during the game and about motivational aspects of the game. Participants recalled procedures better than facts. Information relevant to the progression of the game was recalled better than information that was not. Graphic images and spoken text were recalled more accurately than printed text. Realism, challenge, exploration, and control were factors that influenced motivation. The findings of the current research were specific to a single PC-based first-person-perspective game, but were in agreement with a broad range of research using other types of games and instructional media.

15. SUBJECT TERMS

training technology, PC-based games, computer games, distributed learning, motivation, instruction, desktop simulations

SECURITY CLASSIFICATION OF			19. LIMITATION OF ABSTRACT	20. NUMBER OF PAGES	21. RESPONSIBLE PERSON (Name and Telephone Number)
16. REPORT Unclassified	17. ABSTRACT Unclassified	18. THIS PAGE Unclassified	Unlimited		James Belanich (703) 617-2362

Research Report 1822

INSTRUCTIONAL CHARACTERISTICS AND MOTIVATIONAL FEATURES OF A PC-BASED GAME

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April 2004

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Personnel, Performance and Training

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FOREWORD

The U.S. Army Research Institute for the Behavioral and Social Sciences (ARI), as part of its WEBTRAIN project, investigated the use of distributed-learning technology, such as immersive games and desktop simulations. ARI seeks to provide the Army with guidance on how to develop instructional and motivating PC-based training games.

The focus of this research effort was to identify characteristics of PC-based games that enhance instruction and motivation, not to assess a particular game. The game used for this research was the "America's Army" game, developed by the Office of Economic and Manpower Analysis located at the United States Military Academy to inform potential recruits about the opportunities available through the U.S. Army. The game has been well received by the public, with over two million registered players. In October 2002, the Assistant Deputy Chief of Staff for Training, U. S. Army Training and Doctrine Command (TRADOC) agreed to sponsor ARI research to assess the learning potential of the America's Army game. Data collection was completed with the assistance of the Advanced Distributed Learning (ADL) Co-Lab in Alexandria, VA and the U.S. Army recruiting offices in northern Virginia (Alexandria, Springfield, and Falls Church). Funding was provided by ARI.

The results of this research were briefed to the Director of Training Development and Analysis Directorate and other TRADOC representatives on 3 September 2003 and to the Assistant Secretary of the Army - Manpower and Reserve Affairs on 2 October 2003.

MICHAEL G. RUMSEY
Acting Technical Director

ACKNOWLEDGMENT

The authors acknowledge the cooperation of the U. S. Army recruiting offices of Alexandria, Springfield, and Falls Church, VA for their aid in recruiting participants for this research. We also are thankful to COL Casey Wardynski of the Office of Economic and Manpower Analysis at the United States Military Academy and LTC George Juntiff of the Naval Post Graduate School for their assistance with using the America's Army game. In addition, the authors would like to acknowledge the assistance provided by Richard Christ (ARI, Infantry Forces Research Unit), Mildred Abell and Gary Wright (TRADOC), Franklin L. Moses and Guy L. Siebold (ARI, Advanced Training Methods Research Unit), and Robert A. Wisher (Office of the Secretary of Defense, Advance Distributed Learning Initiative) for their comments and suggestions during this research project.

INSTRUCTIONAL CHARACTERISTICS AND MOTIVATIONAL FEATURES OF A PC-BASED GAME

EXECUTIVE SUMMARY

Research Requirement:

PC-based games are currently being used for instructional purposes in the U.S. military, but the instructional and motivational characteristics of such technology are not well understood. The requirement was to look at a successful PC-based game to identify factors that enhanced motivation and instructional value.

Method:

The game used for this research was the "America's Army" game, a first-person-perspective game developed as a recruiting tool by the Office of Economic and Manpower Analysis at the United States Military Academy. Twenty delayed-entry recruits and one ROTC cadet participated in the research. Participants first completed a pre-game questionnaire assessing prior knowledge of information presented in the game. Next, they played the "basic training" sections of the game, which included Army background information, marksmanship training, an obstacle course, weapons familiarization, and a MOUT (military operations in urban terrain) training mission. After playing the game, participants answered questions regarding information presented during the game and about motivational aspects of the game.

Findings:

Participants recalled procedures better than facts. Information relevant to the progression of the game was recalled better than information that did not influence a player's progression. Graphic images and spoken text were recalled more accurately than printed text. Motivational factors identified by participants as influencing their likelihood to continue playing the game were: challenge (not too hard and not too easy), realism (audio-visual realism and adhering to laws of nature), exploration (opportunity to discover new things), and control (manipulating the virtual environment through keyboard/mouse interface).

Utilization of Findings:

The results of this research provide useful information to individuals developing training games, desktop simulations, and interactive multimedia courseware. The findings can be used as general principles for developing training that is both instructional and motivating. While the research was conducted with a PC-based first-person-perspective game, many of the principles identified may generalize to other types of training games and advanced distributed learning courseware. A presentation based on this research has been incorporated into the TRADOC Immersive Training Workshop held quarterly for U.S. Army instructors and training personnel.

INSTRUCTIONAL CHARACTERISTICS AND MOTIVATIONAL FEATURES OF A PC-BASED GAME

CONTENTS

PC-BASED GAMES/SIMULATIONS: INSTRUCTIONAL CHARACTERISTICS AND MOTIVATIONAL FEATURES

Introduction

For games to be used for training purposes, they should be motivating, but they also need to be instructional. There is no need to develop a training game that is fun to play but doesn't teach anything. The purpose of this research was to assess the instructional and motivational features of a PC-based first-person-perspective game in an effort to develop guidelines for creating effective training games. In a first-person-perspective game, the player sees on the display what the character would see in the game environment. First-person-perspective games tend to involve high-quality graphics and sound effects providing an immersive feel to players because they experience through the computer what the game character would experience visually and auditorily.

The America's Army game was developed by the Office of Economic and Manpower Analysis at the United States Military Academy as a recruiting tool to inform the "recruiting age" public about the U.S. Army. The game is a PC-based first-person-perspective game where players go through virtual "basic training" and then complete on-line military missions as part of a team. The game has been popular; there are over 2 million registered players who have completed over a hundred million missions in just over a year (http://www.americasarmy.com). Based on this volume of usage, players certainly appeared motivated to play the America's Army game. Therefore, it seemed that America's Army game would be an excellent platform to identify some features that motivate users to play first-person-perspective games. Also, given that the game was a vehicle to inform the players about the U.S. Army, the characteristics of the game that influenced learning could be assessed.

Training Games

The military has used PC-based games for training purposes since the 1970's (Herz & Macedonia, 2002; Knerr, Simutis, & Johnson, 1979; Prensky, 2001). Some of these games were developed initially for the commercial purpose of entertainment but were modified for instructional purposes of the military. An early example was in 1978, when Atari modified its game "Battlezone" for the Army to use for training tank tactics (Prensky, 2001).

Previous research indicates that PC-based games can be effectively used for training purposes (Garris, Ahlers, & Driskell, 2002; Gopher, Weil, & Bareket, 1994; Green & Bavelier, 2003; Knerr et al., 1979; Prensky, 2001; Ricci, Salas, & Cannon-Bowers, 1996; Rieber, 1996; Sims & Mayer, 2002). Some research demonstrated that specific skills can be trained with PC-based games (Prensky, 2001; Rieber, 1996; Sims & Mayer, 2002), while other research showed that training games can teach generalized skills like troubleshooting (Knerr et al., 1979) and visual attention (Gopher et al., 1994; Green & Bavelier, 2003). When comparing text-based and PC-based game instructions, Ricci et al. found that skill retention and satisfaction with the training could be improved by converting text-based instruction to a PC-based game format. This demonstrated that games can be effective training tools.

While research has indicated that PC-based games can be effective for instruction, it has not been clear which specific features of games promoted learning or motivation to continue using the game. In a recent experiment, Garris et al. (2002) used a simulation to compare the inclusion of game features such as a high rate of interactivity, scoring, and audio/visual effects against the simulation without such features. They found that the inclusion of all of the game features improved training outcomes. While Garris et al. identified a set of game features that influence training effectiveness, they did not distinguish between individual features. The goal of the current research is to determine specific instructional features (how information or concepts are presented and integrated into the game) and motivational features (what keeps users playing the game) that influence the training effectiveness of PC-based games.

Instructional Aspects

Although little research has been conducted on the specific components of PC-based games that influence instructional effectiveness (Garris et al., 2002), there is a broad base of research on interactive multimedia available (Chandler & Sweller, 1992; Clark, 2000; Craig, Gholson, & Driscoll, 2002; Harp & Mayer, 1998; Mayer, Heiser, & Loon, 2001; Mayer & Moreno, 1998; Moreno & Mayer, 2002; Mousavi, Low, & Sweller, 1995; Schraw, 1998; and Tindall-Ford, Chandler, & Sweller, 1997). Both PC-based games and interactive multimedia share common characteristics, such as audio/visual presentation and user interaction. It is reasonable to assume that results of much of the interactive multimedia research may be applicable to PC-based training games

For any instructional media, there are many ways information can be presented. In an attempt to summarize findings in the area of information presentation, Moreno and Mayer (2000) described 6 principles for producing greater learning of content when using interactive multimedia instruction: (a) *split-attention* – instruction improves when students are not required to split their attention between multiple sources of similar information; (b) *spatial contiguity* – instruction improves when on-screen text and visual material are physically integrated rather than separated; (c) *temporal contiguity* – instruction improves when verbal and visual materials are temporally synchronized rather than asynchronous; (d) *modality* – instruction improves when verbal information is presented as speech rather than visually as on-screen text; (e) *redundancy* – the addition of identical printed text during narration can be distracting and decrease instruction; (f) *coherence* - instruction improves when extraneous material is excluded. Some of these principles of information presentation for interactive multimedia instruction may apply to PC-based training games.

As shown by Moreno and Mayer (2000), how information is presented can directly impact the learning that takes place. One objective of the current research was to evaluate the instructional value of different forms of information presentation. In the current research, we assessed how information was presented along three different dimensions: (a) type of information, (b) relevance to game play, and (c) mode of presentation.

Type of information. Tulving (1972, 1983), Cohen and Squire (1980), and Squire (1987) classified memories into several different types. While this work focused on memory, the same terms can be used for how information is presented in an instructional setting. For this research

we focused on three specific types of information: procedural, episodic, and factual. These three types of information map well into Dale's (1946) continuum of teaching methodologies, which includes doing, observing, and symbolizing. Doing involves direct experiences and simulated experiences. With doing there may be interactivity, while observing only involves watching someone else complete the task (live demonstrations or audio-visual recordings). When observing, there is little control by the learner and minimal interactivity. Symbolizing involves instruction through text (printed and verbal), graphs, and other forms of symbolic communication. With symbolizing, the actual skills and concepts to be learned are not directly shown but must be derived from the understanding of common semantics.

For instructional purposes, learners potentially acquire procedural information when they actually perform a task (doing). Learners potentially acquire episodic information when they experience an event as an observer (observing). Learners potentially acquire factual information when they are provided semantic-based (language-based) information (symbolizing). In a PC-based first-person-perspective game a player could learn information conveyed three different ways: a) attempting the task while receiving game feedback (procedural), observing the game environment (episodic), or the player could be provided printed or spoken text (factual). One of the objectives of the current research was to determine the relative training effectiveness related to these three different types of information in the context of a PC-based first-person-perspective game.

Relevance to game play. During instruction, some of the information presented may be directly relevant to the instructional objectives, while other information may be tangential. The inclusion of non-relevant information, like jokes or non-sequiturs, can make the instruction more interesting, but what is the impact on the training effectiveness?

Research on multimedia instruction has not been favorable to adding irrelevant information. Lower levels of retention and transfer on the important information occurred when interesting but irrelevant information was added to multimedia presentations (Harp & Mayer, 1997, 1998; Mayer et al., 2001). While these researchers illustrated that irrelevant information can distract learners viewing multimedia presentations, no research has investigated the inclusion of irrelevant information in PC-based first-person-perspective games. One of the objectives of the current research was to assess the recall of information that was relevant and was not relevant to a player's progression through the game.

Mode of presentation. In a PC-based first-person-perspective game environment, players can receive information through both audio and visual modalities. Also, visual information can be presented as text or objects. Training game developers have a broad range of options in how they present training material, and one objective of the current research was to assess the impact of how the information was presented.

No research to date has assessed the effect of presentation mode on information recall in the context of PC-based games. Furthermore, research in multimedia instruction seems to be mixed. Tindall-Ford et al. (1997) and Leahy, Chandler, and Sweller (2003) found that when audio and visual information are complementary to one another they are more effective than either one by itself. Mayer and Moreno (1998) found that students retained identical text from

multimedia instructional presentations better through audio channels than through visual channels. Conversely, in some situations, printed text may be superior to audio text. Eberman and McKelvie (2002) found that when asked to visualize the images related to the text, the content of printed text was recalled better than audio information. These differences may be due to the training environment used. The current research further investigated which modes of presentation improve learning in the specific learning environment of a first-person-perspective training game.

Motivational Aspects

Motivation may be defined as what drives purposeful behavior (Lawler, 1994). With regards to instruction, the purposeful behavior can be interaction with the instructional media; in the case of this research, playing the game. For the current research, the objective was to identify features of a first-person-perspective game that motivate a user to continue playing the game. An understanding of motivating features may allow training game designers to keep learners engaged in the training activity for extended periods.

Training motivated learners is far easier than training non-motivated learners (Prensky, 2001). Sometimes the subject matter provides the motivation for the learner, while other times how the instruction is conducted can influence motivation. The theory behind training games suggests that the act of playing a game should motivate the learners to continue playing, thereby continuing to learn. If information is embedded in the game, than continuance in playing the game should result in more material being introduced to the learner.

In a series of experiments, Malone (1981) and Malone and Lepper (1987) identified four features of PC-based games that promote motivation to continue playing. The four features were: (a) *challenge* - the activity provides an intermediate level of difficulty; (b) *control* - the ability to determine the outcome of events based on the player's actions; (c) *curiosity* - the belief that the player will uncover something new; and (d) *fantasy* - the feeling that players are engaging in an activity that is not real. In addition to Malone's research on motivation for games, others have also assessed features that influence motivation. For example, Corbeil (1999) investigated role-playing and first-person-perspective games and identified six motivating aspects: (a) self-discovery, constructivism; (b) self-validation, efficacy; (c) escape, a break from reality; (d) camaraderie, social; (e) creative competition, feedback; and (f) a metaphor for life, related to reality. Garris et al., (2002) reviewed previous research on motivation in training games and found six similar game characteristics which they thought would influence motivation: fantasy, rules/goals, sensory stimuli, challenge, mystery, and control. In the current research, we identified characteristics of a particular first-person-perspective PC-based game that may motivate players to continue playing and characteristics that may not motivate continued play.

Method

Participants

Twenty-one individuals participated in the experiment. The average age of the participants was 20.4 years old, with a range from 17 to 29. Twenty of the participants were

delayed entry recruits, i.e., individuals who made a commitment to enlist but had not yet started basic training. One participant was a first-year member of an ROTC (Reserve Officers Training Corps) program. While all of the participants had made some commitment to the U.S. Army, none had gone through basic training.

Apparatus

The America's Army game was used as the platform for this experiment. The America's Army game is a first-person-perspective adventure/shooting game with advanced graphics and sound effects. In this game, players go through virtual "basic training" and then complete on-line military missions as part of a team. The minimum system requirements for America's Army include: Microsoft Windows 98/ME/XP/2000, a Pentium III processor running at 700 MHz with 128 MB of RAM, 1.5 GB of hard drive space, and an internet connection. This research focused on the individual player "basic training" section.

Procedure

Pre-game data collection. Participants were first asked to complete demographic questions and a nine-item multiple-choice questionnaire to measure prior knowledge about the game and the U.S. Army. Each item had five probable answers including an "I don't know" choice. See Appendix A for the pre-game questionnaire.

Play game. After completing the pre-game questionnaire, participants then played the first four sections of the game: a) marksmanship training, b) an obstacle course, c) weapons familiarization, and d) a MOUT (military operations in urban terrain) training mission.

The marksmanship section began with a printed text description of basic training, marksmanship training, and a brief history of Fort Benning. Next, a computer-generated drill instructor verbally explained what was required in the marksmanship training section. The player then took a position in the shooting range with their rifle (M-16A2) and ammunition. The player was provided instructions on tasks like loading the gun and the number of targets they needed to hit to qualify with their weapon. The practice and qualification rounds were repeated until the participant qualified (at least 23 out of 40 targets with 40 rounds).

The next section was the obstacle course, which began with the same printed text pages about basic training and the history of Fort Benning. Additional text was added to describe obstacle course training in the U.S. Army. Following the text sections, instructions for player movement were given verbally by the drill instructor while the player virtually ran through the course on a practice run. The obstacle course included obstacles like climbing over a wall, running over a balance beam, and low crawling under barbwire. After completing the practice run, the player ran the entire course against a clock. Each player repeated this until they bettered the time requirement of 90 seconds.

The third section was weapons familiarization, which began with printed text about basic training, the history of Fort Benning, and a description of some of the weapons used by the U.S. Army. Then, the players had the opportunity to use four different weapons: a machine gun, a

rifle with a grenade launcher, fragmentation grenades, and smoke grenades. Unlike in the previous sections, there was no standard to meet before going on to the next section.

The final section was MOUT training, which began with another printed text presentation about basic training, the history of Fort Benning, and a description of infantry training. Then, players had to navigate through a building and various tunnels while shooting at stationary silhouettes of combatants, distinguishing them from the silhouettes of innocent bystanders. During this section the players used movement skills developed in the obstacle course and their shooting skills developed in marksmanship and weapons familiarization. This section also introduced "rules of engagement", which dictated that one was to only shoot "hostile" targets, while not shooting "noncombatant" targets.

Post-game data collection. Upon completion of "Basic Training" each participant completed a 35-item multiple-choice questionnaire on information presented during the game (Appendix B). As with the pre-game questionnaire, each multiple-choice question had five possible answers, including an "I don't know" choice. Nine of the multiple-choice questions were repeated from the pre-game data collection, so the remaining 26 were used to assess instructional features. Also included in the post-game questionnaire were five open-ended questions, four of which were used to assess game characteristics that might influence motivation. The first open-ended question was "what about the 'America's Army' game would make you want to play the game again?" This question directly measured what features of the game motivated participants to want to continue interaction with the program. The second question, "which section of the basic combat training did you like the most, and why?' prompted responses regarding what they like most about the game. It was thought that assessing the positive features of the game would indicate reasons participants would be motivated to continue playing the game (motivating features). The third and fifth questions assessed what about the game they liked least or would change, which should reflect non-motivating characteristics of the game. The fourth question was a motivation-neutral question assessing what they learned during the game and was not used in this report.

The 26 multiple-choice questions that appeared only in the post-game questionnaire were classified along three different instructional characteristics: type of information, relevance of information to game play, and mode of presentation. Items were classified as belonging to different subsets of information type using the following definitions: (a) procedural – cognitive or motor skills and activities; (b) episodic – experiential memories of sensation, perception, and past events; and (c) factual - facts and concepts represented by text and symbols. For relevance to game play, items were classified as belonging to the subsets defined as: (a) relevant – information that is required or helpful to progress in the game and (b) irrelevant – information that does not impact on progress in the game. Finally, items were classified by their mode of presentation using the following subset definitions: (a) spoken text – narrated information, (b) printed text – printed information, and (c) graphic images. Five questions on the post-game questionnaire assessed information that was presented through more than one modality, so only 21 questions were used in the assessment of the effect of presentation modality. The classifications (p=procedural, e=episodic, f=factual, rl=relevant, ir=irrelevant, spk=spoken text, prn=printed text, and grp=graphic image) for each question are presented next to the question in Appendix B.

After these categories and their definitions were developed/researched, two of the researchers separately classified each of the items into their appropriate information type, relevance, and presentation mode categories. The initial inter-rater agreement [agreements/(agreements + disagreements)] for the characteristics of information type, relevance to game play, and mode of presentation were deemed acceptable at .91, .89, and 1.0, respectively. The items that authors disagreed on initially were then discussed until a mutual consensus for categorization was reached.

Responses were grouped into four categories based on previous research on motivation (Malone, 1981; Malone & Lepper, 1987) and the terms used by the participants in their responses. These categories were: challenge, control, realism, and exploration. Challenge was defined as a response that discussed accomplishing the tasks required to continue on to the next section in the game or goal achievement (e.g., "it was fun trying to complete the obstacle course in only 90 seconds"). Control was defined as a response regarding the interaction of the player with the game environment (e.g., "I enjoyed seeing the targets fall when I shot them"). Realism was defined as responses about elements that made the game experience more representative of a real-life experience. This category included comments about the games high visual and audio fidelity, as well as responses about realistic weapons and procedures. Exploration was defined as responses that discussed the process of discovery and novel sensory stimulation (e.g., seeing a new weapon or participating in a new activity like MOUT).

Two researchers independently coded all responses to the open-ended questions. The codings of both researchers were compared to calculate inter-rater agreement. Inter-rater agreement for questions about what motivated participants to continue playing and the initial inter-rater agreement for questions about what failed to motivate were deemed acceptable at .81 and .87, respectively. The responses that coders initially disagreed on were then discussed until consensus was reached.

Results

Pre-game data

The nine pre-game questionnaire items were used to determine whether participants were naïve to the information presented during the game. The mean score for the pre-game questionnaire was 19.6% with a standard deviation of 16.4% (range = 0-56%), indicating that participants were not familiar with much of the game related information.

Information Type

Three different types of information were assessed through the post-game questionnaire: procedural (knowledge of a skill or activity); episodic (knowledge of past events, experiential memories of sensation and perception); and factual (knowledge that one represents symbolically, such as facts and concepts). Of the 26 items used to assess information type, 6 were classified as procedural, 8 as episodic, and 12 as factual.

The percentage of questions answered correctly for each subset of information type are displayed in Figure 1. The I-bars indicate the standard error for each type of information subset. For procedural information, across all participants the mean percentage correct was 77.9% with a standard error of 5.3%. For episodic information, the mean was 70.5% with a standard error of 3.1%. For factual information, the mean was 62.9% with a standard error of 4.3%. The difference between the mean accuracy scores was significantly different (one-way ANOVA, F=4.0, p= .026). A Tukey pairwise comparison found a significant difference between the procedural and factual means (p< .05). Using Cohen's d, the effect size between procedural and factual was .73. The effect size between episodic and factual was .37, and the effect size between procedural and episodic was .36. Cohen's d was calculated as [Cohen's $d = (\text{Mean}_1 - \text{Mean}_2) / \text{standard deviation}_{\text{pooled}}$].

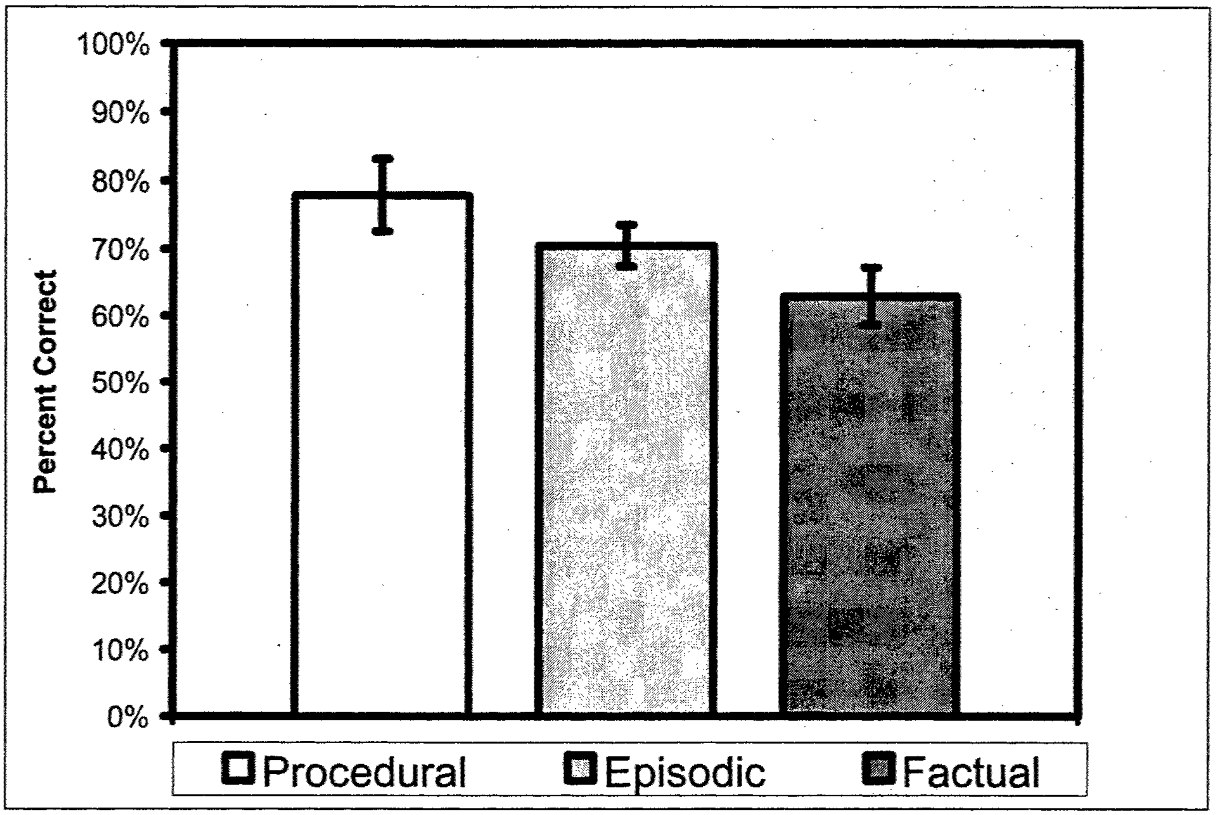

Figure 1. The mean percentage correct for questions involving the three different types of information (procedural, episodic, and factual).

Relevance to Game Play

Questions from the post-game questionnaire were categorized as either relevant to player progress through the game or irrelevant to game play. Of the 26 items pertinent to the issue of relevance, 16 were classified as relevant to game progression, while the remaining 10 were classified as irrelevant.

The percentage of questions answered correctly for each relevance category is displayed in Figure 2. For relevant information, the mean accuracy score was 72.3% with a standard error

of 3.6%. For irrelevant information, the mean was 58.7% with a standard error of 4.8%. Relevant information was recalled at a statistically significant higher level than irrelevant information (paired sample *t*-test, t=2.29, p>.01). Using Cohen's *d*, the effect size between relevant and irrelevant was .65.

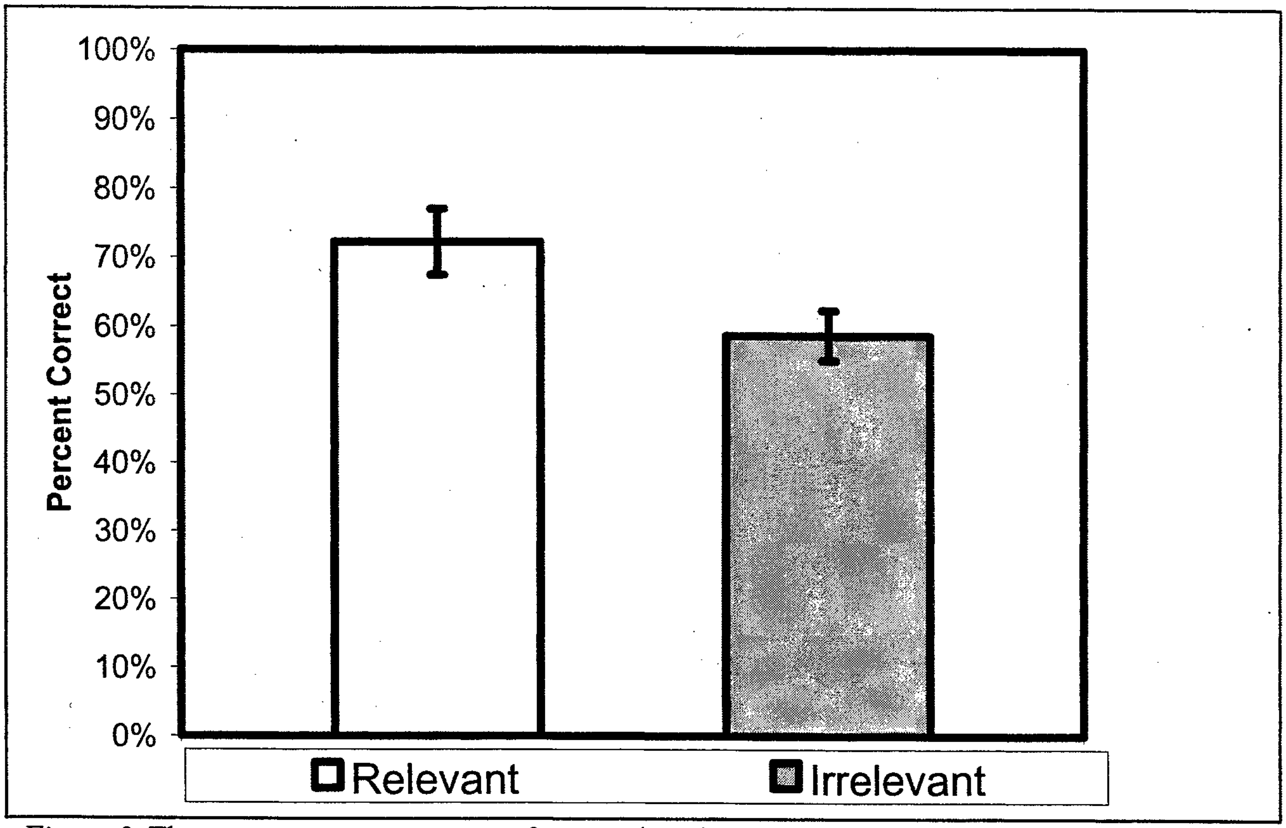

Figure 2. The mean percentage correct for questions involving relevant and irrelevant information.

Presentation Modality

Questions from the post-game questionnaire were categorized based on presentation modality (printed text, spoken text, and graphic images). Of the 21 questions used to assess presentation modality, 6 were classified as graphic images, 4 as spoken text, and 11 as printed text. Five questions were not used in the analysis of this variable, because the information was presented in more than one modality.

The percentage of questions answered correctly for each category of presentation modality is displayed in Figure 3. For graphic images, the mean was 79.1% with a standard error of 3.4%. For spoken text, the mean was 73.8% with a standard error of 5.0%. For printed text, the mean was 57.1% with a standard error of 4.3%. The difference between the mean scores based on modality of presentation was significantly different (one-way ANOVA, F=9.3, p<.01). A Tukey's pairwise comparison identified a significant difference between graphic images and printed text (p<.01) and a difference between spoken text and printed text (p<.05). Using Cohen's *d*, the effect size of the difference between graphics and printed text was 1.02, while the

effect size for spoken text verses printed text was .77. The effect size for the difference between graphics and spoken text was .25. Cohen's *d* was calculated as [Cohen's $d = (Mean_1 - Mean_2)$ / standard deviation $_{pooled}$].

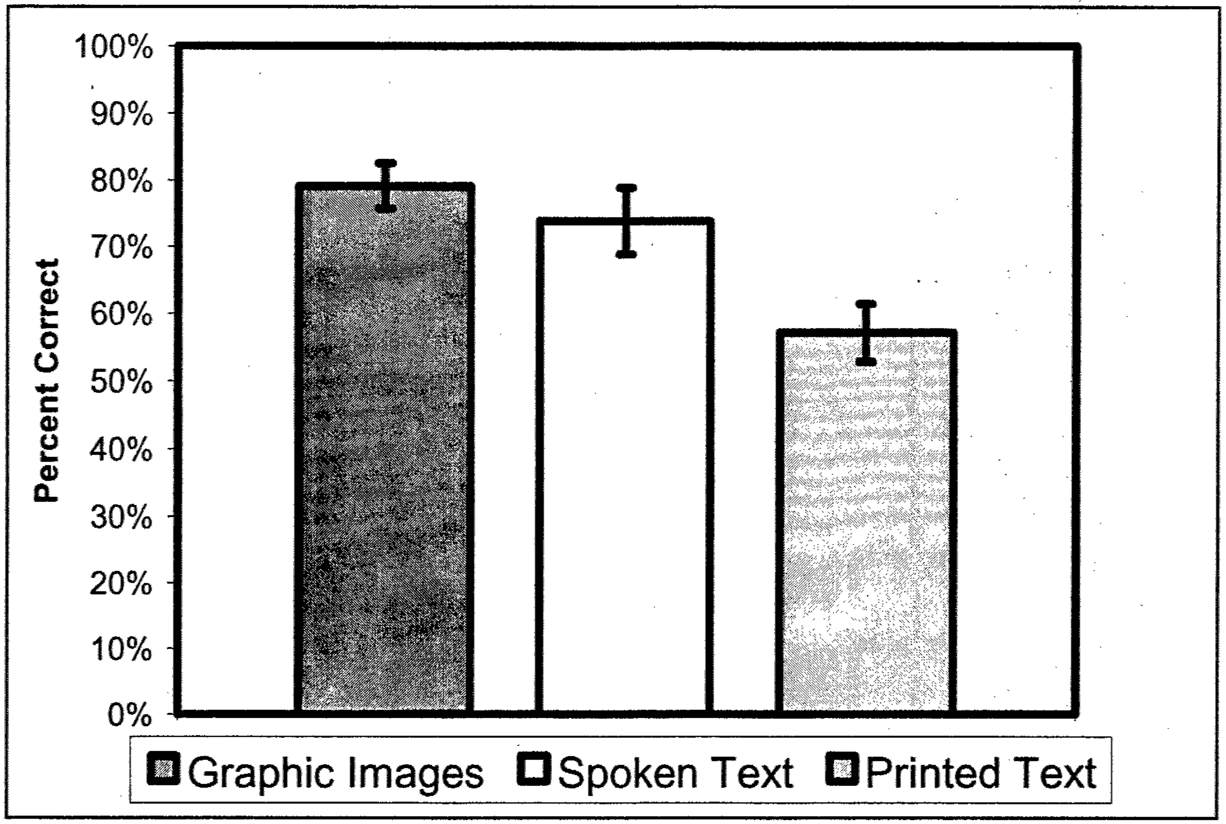

Figure 3. The mean percentage correct for questions involving the three different types presentation formats of information.

Motivation

Features that motivate. There were 25 responses to the two open-ended questions assessing the motivational features of the game. Not all participants responded to the questions used to assess motivation, and some participants wrote more than one response. The responses for what might motivate them to continue playing the game fell within four categories: realism, challenge, exploration, and control (see Figure 4). Twenty of the responses were coded into one of the four categories; nine mentioned realism, six mentioned challenge, three mentioned exploration, and two mentioned control over the game environment. Additionally, there were five responses that were not expressed in the figure because the responses did not clearly express a reason why the game was motivating; they were either tautological (i.e., "I liked it because it was fun") or statements that they found no part of the game motivating.

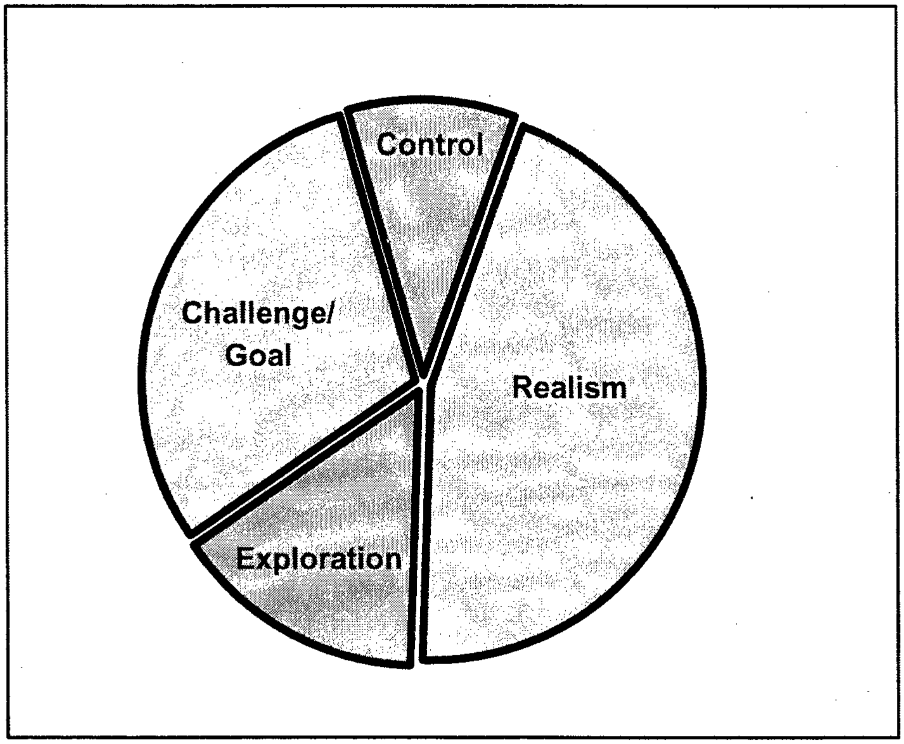

Figure 4. Proportion of responses by category of feature that motivated participants to continue playing.

Features that did not motivate. There were 25 responses to the two open-ended questions assessing the non-motivational aspects of the game. These fell within the 3 categories of realism, challenge, and control (Figure 5). Eighteen of the responses were coded into one of the following categories, eight responses mentioned a lack of control, five mentioned the game not being challenging enough, three stated that the game was too challenging, and two mentioned a lack of realism. Seven responses did not clearly express reasons the game was not motivating and were not expressed in the figure.

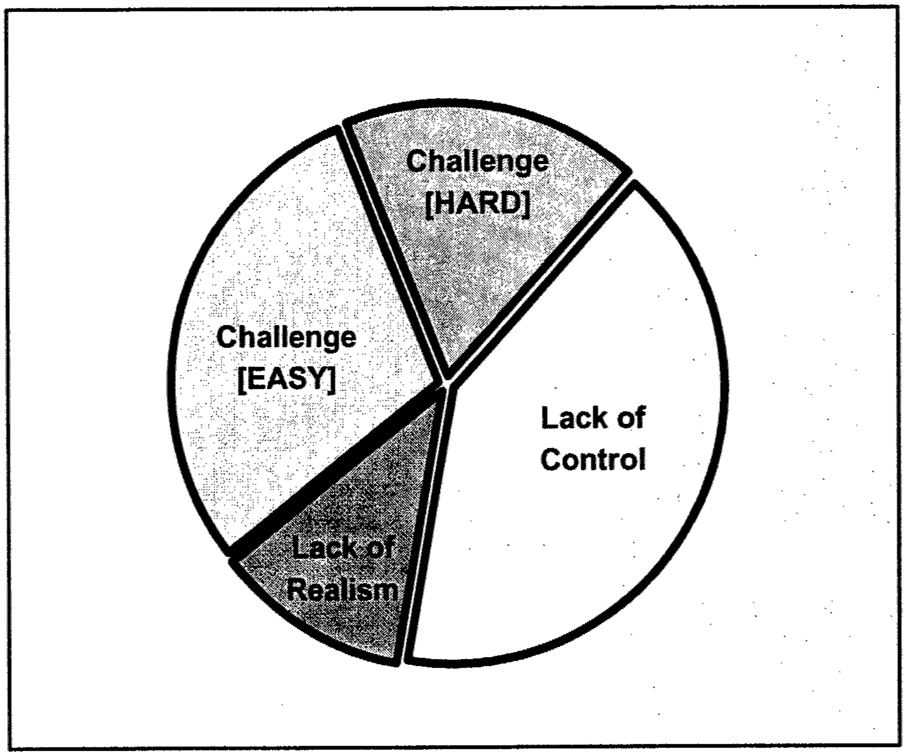

Figure 5. Proportion of responses describing features that did not motivate participants to continue playing.

Discussion

Instructional Characteristics

Information type. In the current experiment, subjects recalled procedural information at a higher rate than factual information. This indicates that within the context of PC-based first-person-perspective games, procedural information was learned better than factual information. This finding relates to Dale's (1946) continuum of instruction methodology of doing, observing, and symbolizing. Doing correlates with procedural information, observing correlates with episodic information, and symbolizing correlates with factual information. The current research supports Dale's guidelines that what is done (procedural) is learned best, followed by what is observed (episodic), and symbolic information (factual) is least likely to be learned.

While participants performed better on procedural and episodic questions, factual information was still recalled. Some instructional information will be naturally structured as factual information; therefore, factual information should not be disregarded completely but should be used in a targeted manner.

Little research has compared the retention of different types of information presented in training environments. In research on individuals with amnesia, they were more likely to remember procedural information than factual information (Cohen & Squire, 1980; Squire, 1987). While these findings are in agreement with the current research findings and may suggest that procedural information is more resistant to forgetting than factual information, additional

research with training games is needed to demonstrate the generality of the current research results.

Relevance. In the current experiment, information that was relevant to the progression of the game was recalled more accurately than information tangential to player progression. This suggests that training game developers should incorporate learning objectives into the storyline of the game. If the training objectives are not part of the game's storyline, the player may remember how to play the game instead of learning the training objectives.

Beyond the beneficial effect that relevant information may have, there may also be a damaging effect of having information that is not relevant to the topic of instruction. As mentioned in the introduction, it has been demonstrated in multimedia instruction research that the inclusion of non-relevant details can be distracting and have detrimental effects on retention and learning transfer (Harp & Mayer, 1997, 1998; Mayer et al., 2001). This line of research, along with the findings of the current experiment, suggest that relevant information will be recalled better than irrelevant information, and the inclusion of irrelevant information is less likely to be recalled and in some cases may possibly impede the learning of the relevant information.

Mode of presentation. Findings indicate that spoken text and graphic images were recalled more accurately than printed text. This extends previous findings of Mayer and Moreno (1998) to a first-person-perspective game, where they found that students retained identical text from multimedia instructional presentations better through audio channels than through visual channels. This suggests that across a range of audio-visual environments, information presented as spoken text may lead to better retention than printed text.

Given our findings, one may think that only graphic images or spoken text, and not written text, should be used for instruction in this medium. However, for several reasons, this is not the case. First, a casual observation during the experiment indicated that some participants skimmed or ignored full pages of text by merely clicking on "next" to proceed to the next page without ample reading time. This suggests that large blocks of written text may be ignored by some players in first-person-perspective games and may account for these findings. It is important to note that text was recalled, but only to a lesser extent. This may simply be due to the fact that students were able to control whether or not they could skip the written text information. This was not an option for spoken text or graphic images. Differences may be due to whether or not participants received the information rather than how it was displayed. Future research should investigate this difference. Secondly, previous research has shown that when audio and visual information are complementary to one another they are more effective than either one by itself (Leahy et al., 2003; Tindall-Ford et al., 1997) Therefore, the combination of text and graphic images, whereby one complements the other, may be an effective way to provide instruction.

Motivation Features

Based on the responses of the participants to the open-ended questions, there were four game features that influenced motivation to continue playing: challenge, realism, control, and

exploration. These four categories are similar to those presented by Malone (1981) and Malone and Lepper (1987), which were: challenge, fantasy, control and curiosity.

Challenge. Across features that positively and negatively affected motivation, challenge was the most frequently mentioned. This indicates the potential importance of attaining an optimal level of difficulty so as to motivate participants, a finding that is in line with Malone's research on motivational features of PC-based games (Malone, 1981; Malone & Lepper, 1987). Malone stated that an optimal level is reached when a participant finds an activity difficult, without finding it overwhelming. If the task is too simple and the person is guaranteed success, it may be perceived as boring, and if it is too difficult, the individual may become frustrated (Rieber, Davis, Matzko, & Grant, 2001).

Individuals in the current research reported sections of the game as being too challenging or not challenging enough. It is likely that participants came in with different amounts of game playing experience; therefore, it is not surprising to find that a specific level of difficulty was not applicable across all participants. In order to challenge an individual at an appropriate level, training games can be designed with a dynamic level of difficulty (Garris et al., 2002; Malone & Lepper, 1987; Prensky, 2001). As a player progresses through the game easily the level of difficulty increases, or if a player has problems the level of difficulty decreases. A training game where the degree of challenge matches the performance level of the player may motivate the broadest range of players.

Control. Control existed when a player felt that their performance was directly related to outcomes in the game environment. In this experiment, only a few responses mentioned control as a motivating feature (2), while a larger number of responses (8) identified a lack-of-control as being a negative feature and potentially non-motivational. The prevalence of negative remarks relative to positive remarks suggests that either a sense of control was more frequently absent than present in the game or that subjects have a tendency to notice the absence of control more then its presence. In either case, the data suggest that training game designers should provide players with a sense of control over the game environment.

Malone and Lepper (1987) suggested that controlling one's environment is a motivating factor contributing to enjoyment of PC-based games. Previous research found a relationship between completion rates in academic online courses and feelings of control. Students who felt more in control of their environment had higher completion rates of courses than individuals who did not feel in control (Dille & Mezack, 1991; Parker, 2003). Therefore, it is likely that individuals may be more willing to persist in a training game if it endows them with feelings of control.

Greater control has also been linked with increased learning. Research has shown that when an individual controls the rotation of a three-dimensional object they have faster recognition of the object than individuals who observed the same rotation passively (James, Humphery, Vilis, Corrie, Baddour, & Goodale, 2002). These findings along with the findings of Parker (2003) and Dille and Mezack (1991) suggest that a sense of control leads to both higher motivation and greater learning.

Realism. Realism was the most commonly mentioned reason to continue playing the game. Some participants also mentioned that a lack of realism was a reason that they did not find parts of the game motivating, suggesting that realism is an important feature of first-person-perspective games.

Malone's (1981) element of fantasy relates to the category of realism used in the current research. It could be argued that the realistic nature of the game promoted the fantasy (immersion) that individuals were engaged in something beyond just playing a game. The inclusion of fantasy, or "suspension of disbelief", could be motivational in a training game because it provides a context for the learning activity that provides experiences not otherwise readily available to an individual (e.g., qualifying with a rifle, throwing a grenade, or completing an obstacle course), all while sitting in front of a computer.

Outside of motivational benefits, there is an additional purpose to creating a realistic environment. It has been demonstrated that increased transfer of training occurs when there was greater similarity between the training environment and the performance environment (Auffrey, Mirabella, & Siebold, 2001; Detterman, 1993; Thorndike & Woodworth, 1901). Given that the purpose of training games are to improve performance on an actual task, the games should realistically represent the elements of the real-world environment that are pertinent to the instructional objectives of the training game.

While realism may be beneficial, training game developers should be wary of overly investing resources in graphics and audio realism. High fidelity graphics and audio can be expensive to produce, and it appears that there are diminishing educational returns from high fidelity systems (Baum, Riedel, Hays, & Mirabella, 1982; Freda & Ozkaptan, 1980; Morris & Tarr, 2002). For example, Morris and Tarr (2002) found that quality of decision-making actually decreased with higher levels of graphics. This suggests that while realism is a feature that may motivate players, there is a limit where greater levels of realism may no longer increase the effectiveness of a training game.

Exploration. Proper use of exploration was mentioned as motivational, but was not mentioned as un-motivational. There are two possible explanations for this finding. First, this particular game could have stimulated adequate levels of exploration for all individuals. The second possible reason is that individuals might not readily notice inadequate levels of exploration; therefore they would not report the absence of exploration. Whatever the reason, future research should investigate the role of exploration in learner motivation.

The feature of exploration is similar to Malone's (1981) curiosity. Malone considers curiosity to occur when an individual searches out knowledge gaps. Researchers have suggested that curiosity is a fundamental and powerful human drive to acquire novel information, for no immediate external purpose and thus for no immediate external reward (Kashdan & Fincham, 2002). Thus, this particular motivational element in a PC-based game is naturally entwined with the learning process and may be harnessed for instructional purposes.

Optimal levels of game features. Of the four motivational features mentioned as reasons for continuing to play the game, three of those features were also mentioned as reasons for not

continuing to play the game. This indicates that not all of the four motivational features were at optimal levels. For example, with regards to challenge, some individuals identified sections of the game as too difficult, while others identified sections as too easy. In the case of realism, many participants praised the level of the game's realism, while a few individuals identified the game as not realistic enough. An attempt to identify a single optimal level of any one of these features would be difficult because preference varies across individuals. Differences in individual preference for control, realism, exploration and challenge could originate from a myriad of sources, such as culture, current mood, hand-eye coordination, past play experiences and visual preferences. Because of individual differences, a system that allows for the variation of these levels may be beneficial to learner motivation.

Many variable systems have been used in commercial games. Most games offer variable levels of difficulty, where a player may select between beginner, intermediate, and expert levels. Some games allow for varying levels of realism by permitting a user to select the level of "gore", which determines how much blood will spurt when a person is shot. Other games contain optional "quests" for individuals who wish to engage in more or less exploration of the game. Additionally, there are games that allow users to choose a level of assistance for help controlling the game, where they can toggle "auto-aim" and the computer controls the aiming of the player's gun. Varying these features allows the game to appeal to a broader range of players.

The control of these systems may take many forms. One option is to allow the player to set the level of the particular game feature. A second option is where an instructor would select the level based on the instructional objectives. A third mechanism would be to have an automated system that attempts to identify the optimal level for a player based on their performance. An early version of this mechanism of variable levels of challenge was used in the arcade game "Pac-Man" (Bowman, 1982), where players began at a simple level and progressed to harder levels when they were successful at a prior level. A combination of these features may be appropriate. For example, the game designer/instructor might select the level of realism based on the training objectives, the player might select the level of exploration and control, while the game might regulate the level of challenge based on the player's performance.

In this research, all four motivational features were mentioned as reasons players may be motivated to continue playing the game, while only three of the categories were mentioned as reasons that may be non-motivating with regards to players continuing to play the game (challenge, control, and realism). However, it is not clear in these data as to what mix of these features are most beneficial towards motivating participants to continue playing. Nor do we have data that support the actual continuance of playing. These data simply provide participants reactions on what they found most interesting and engaging, which should indicate what factors would lead them to play in the future. Previous research by Malone and Lepper (1987) noted that while these elements influence motivation, their presence will not guarantee motivation nor will their absence preclude motivation. Taken together, it is reasonable to expect that these four features of intrinsic motivation should be treated as areas of concern when creating a training game and not as strict requirements until further research is completed.

Conclusions

In the current research, features of a PC-based training game were assessed in an attempt to identify aspects of a first-person-perspective game that would influence both the learning of content and player motivation to continue using the game. For the current research, the findings related to the instructional characteristics (information type, relevance of information, and presentation modality) may be limited to the PC-based first-person-perspective game used. However, the findings mirrored previous findings from research using interactive multimedia instruction. Likewise, the findings regarding motivation in this game confirmed previous research on motivational aspects of other types of games.

The assessment of instructional features suggest that PC-based training games would be more effective for learning procedures than for learning facts. Additional research would be needed to determine if types of skills and procedures influence the effectiveness of using games for training, or if the type of game influences the effectiveness of the training.

The findings also suggest that instructional objectives should be integrated into the game's storyline so that the training material is relevant to the progression of the game. If the training objectives are part of the storyline of the game, the training effectiveness of the game may be increased. If the training objectives are not part of the storyline, then players/students may only learn how to play the game and not the training objectives. The relevance of the training objectives also overlaps with the motivational feature of realism, which should increase the likelihood of skill transfer from the game to the application of the skill trained.

Spoken text and visual images were found to be more effective presentation modalities than printed text, suggesting that course developers should focus on these modes of presentation. It does not mean that printed text should be abandoned completely, only that it should be limited during game play. Casual observation of the participants in this research showed that players might skip large portions of text.

The assessment of motivational features suggest that PC-based training games should be designed with attention to challenge, realism, control, and opportunities for exploration, which may make the learner's experience more positive and motivate them to continue using the game. While the inclusion of all of these features does not guarantee that users will play the game for hours on end, they are features that should be considered while developing a training game.

For a training game to be effective, it should be both instructional and motivational. Additionally, some of the instructional features identified may influence motivation, and some of the motivational features identified may influence instruction. More research is needed to develop a better understanding of the interaction of instructional and motivational influence on the training effectiveness of first-person-perspective games.

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Appendix A
Pre-Game Questionnaire

Subject ID:

Participant Questions

1. What is your age?

_____ years

2. What is your level of confidence using computers (please circle one)?

1	2	3	4	5
Low		Average		High

3. On average, how many hours per week do you use computers (for example, schoolwork, e-mail, instant messaging, entertainment)?

_______ Hours/week

4. In the past year, on average, how many hours per week have you spent playing any type of video game (for example, PC-based, Nintendo, Playstation, arcade)?

_______ Hours/week

5. Have you played the America's Army PC-based game?

_______ Yes _______ No

If yes, approximate number of hours played. ________

6. What computer games and/or video games do you prefer? (List as many titles as you like)

Circle the correct answer. If you are unsure of the answer, circle choice E.

1. How do you switch between firing modes (1 shot, or three round burst)?
   A) R
   B) T
   C) Right mouse button
   D) Mouse wheel
   E) I don't know

2. What else is the M249 machine gun called?
   A) Suppression Fire Weapon
   B) Squad Automatic Weapon
   C) Tactical Action Munitions
   D) Tactical Automatic Munitions
   E) I don't know

3. In the MOUT training, where do you NEED to use the night vision goggles?
   A) For clearing the first room
   B) In the tunnels
   C) On the entire course
   D) In the fuselage
   E) I don't know

4. What are the Army's 7 core values?
   A) loyalty, duty, respect, selfless service, honor, integrity, and personal courage
   B) loyalty, dignity, fortitude, honesty, bravery, ingenuity, and personal courage
   C) loyalty, duty, bravery, honor, dignity, respect, and dignity
   D) loyalty, dignity, respect, selfless service, honesty, ingenuity, and personal courage
   E) I don't know

5. How do you change magazines, or reload the gun?
   A) Press R
   B) Press C
   C) Press E
   D) Press V
   E) I don't know

6. What are the positions that you shoot from during the qualifying round?
   A) standing and crouching
   B) standing and prone
   C) crouching and prone
   D) supported and prone
   E) I don't know

7. When running the obstacle course for time, where is the clock located?

A) Top right
B) Bottom right
C) Top left
D) Bottom left
E) I don't know

8. What key do you press to get into position so that you can GET under the barbed wire in the obstacle course?

A) X
B) Y
C) C
D) Z
E) I don't know

9. What color are the targets during rifle qualifying?

A) White
B) Green
C) Blue
D) Red
I don't know

Appendix B
Post-game Questionnaire

Subject ID: ____________________

Circle the correct answer. If you are unsure of the answer, circle choice E.
(Note: the following codes were used to identify the categories used for this research for each question; p= procedural, e=episodic, f=factual, rl=relevant, ir=irrelevant, grp=graphic, spk=spoken text, prn=printed text, and mul=information was presented through multiple modalities. "Pre-game" was used to identify items that appeared on the pre-game questionnaire. These codes did not appear on the questionnaire given to the participants.)

1. What is the reason the Sergeant gives for "cooking" off a grenade before throwing it? (f, rl, spk)
   A) To make sure its not a dud
   B) To make it detonate
   C) So the enemy won't throw it back at you
   D) So you won't hit a friendly
   E) I don't know

2. How do you switch between firing modes (1 shot, or three round burst)? (pre-game)
   A) R
   B) T
   C) Right mouse button
   D) Mouse wheel
   E) I don't know

3. What animal does the Drill Sergeant use in his description of how to get through the tunnel obstacle? (e, ir, spk)
   A) a snake
   B) a goose
   C) a chicken
   D) a duck
   E) I don't know

4. What else is the M249 machine gun called? (pre-game)
   A) Suppression Fire Weapon
   B) Squad Automatic Weapon
   C) Tactical Action Munitions
   D) Tactical Automatic Munitions
   E) I don't know

5. During basic rifle marksmanship qualifying, how many rounds are in a magazine? (f, rl, mul)
   A) 10
   B) 15
   C) 20
   D) 25
   E) I don't know

6. What are the two types of obstacle courses? (f, ir, prn)
   A) Conditioning and Teamwork
   B) Teamwork and Confidence
   C) Conditioning and Confidence
   D) Conditioning and Shampooing
   E) I don't know

7. What is written on the lane posts of the obstacle course? (e, ir, prn)
   A) USA
   B) Army of One
   C) Go Army
   D) The Army's seven core values
   E) I don't know

8. What other specialized schools are housed at Fort Benning? (f, ir, prn)
   A) sniper, airborne, pathfinder, and ranger schools
   B) special forces, intelligence, and transportation schools
   C) artillery, intelligence, and sniper schools
   C) ranger, sniper, and signal schools
   D) I don't know

9. During basic rifle marksmanship qualifying, how many targets must you hit to qualify as a marksman, so that you may continue with the game? (f, rl, mul)
   A) 23
   B) 27
   C) 32
   D) 36
   E) I don't know

10. What does MOUT stand for? (f, ir, prn)
   A) Military Options on Unidentified Target
   B) Mastering Operations in Underground Terrain
   C) Military Operations in Urban Terrain
   D) Mastering Operations and Urban Tactics
   E) I don't know

11. During the obstacle course, which colored lane do you run down? (p, rl, spk)
   A) Green
   B) Blue
   C) White
   D) Red
   E) I don't know

12. In the MOUT training, where do you NEED to use the night vision goggles? (pre-game)
   A) For clearing the first room
   B) In the tunnels
   C) On the entire course
   D) In the fuselage
   E) I don't know

13. What are the Army's 7 core values? (pre-game)
   A) loyalty, duty, respect, selfless service, honor, integrity, and personal courage
   B) loyalty, dignity, fortitude, honesty, bravery, ingenuity, and personal courage
   C) loyalty, duty, bravery, honor, dignity, respect, and dignity
   D) loyalty, dignity, respect, selfless service, honesty, ingenuity, and personal courage
   E) I don't know

14. How do you change magazines, or reload the gun? (pre-game)
   A) Press R
   B) Press C
   C) Press E
   D) Press V
   E) I don't know

15. During both rifle qualifying and weapons familiarization what compass direction do you shoot? (e, ir, prn)
   A) North
   B) South
   C) East
   D) West
   E) I don't know

16. What is the order of the obstacles in the course? (e, ir, grp)
   A) side step, high/low logs, climb up the ladder to high beam, wall, log ladder to the cargo net, tunnel, low beam over the sand pit, and under the barb wire.
   B) side step, wall, log ladder to the cargo net, high/low logs, climb up the ladder to high beam, tunnel, low beam over the sand pit, and under the barb wire.
   C) side step, wall, log ladder to the cargo net, high/low logs, climb up the ladder to high beam, tunnel, low beam over the sand pit, beams with the cargo net, and under the barb wire.
   D) side step, high/low logs, tunnel, low beam over the sand pit, climb up the ladder to high beam, wall, log ladder to the cargo net, and under the barb wire.
   E) I don't know

17. What are the positions that you shoot from during the qualifying round? (pre-game)
   A) standing and crouching
   B) standing and prone
   C) crouching and prone
   D) supported and prone
   E) I don't know

18. How much time do you have to complete the obstacle course? (f, rl, prn)
   A) 60 seconds
   B) 90 seconds
   C) 120 seconds
   D) 180 seconds
   E) I don't know

19. During MOUT where do you have to throw a flash bang? (p, rl, grp)
   A) Down the tunnel
   B) Up the tunnel
   C) Into the first room
   D) Into the last room
   E) I don't know

20. How many rounds are in a belt for the M249 machine gun? (f, rl, spk)
   A) 20
   B) 100
   C) 200
   D) 400
   E) I don't know

21. What generally is the shape of the smoke grenade? (e, ir, grp)
   A) a ball
   B) a can
   C) a bottle
   D) a box
   E) I don't know

22. What "fire point" does the drill sergeant send you to for rifle training and qualification? (f, rl, mul)

A) 3
B) 5
C) 7
D) 9
E) I don't know

23. How do you bring the gun up so that you can look directly through the sites? (p, rl, prn)

A) Press Z
B) Press A
C) Press Q
D) Press R
E) I don't know

24. When running the obstacle course for time, where is the clock located? (pre-game)

A) Top right
B) Bottom right
C) Top left
D) Bottom left
E) I don't know

25. What key do you press to get into position so that you can get under the barbed wire in the obstacle course? (pre-game)

A) X
B) Y
C) C
D) Z
E) I don't know

26. What color are the targets during rifle qualifying? (pre-game)

A) White
B) Green
C) Blue
D) Red
E) I don't know

27. How do you toggle (switch) between sprint and walk? (p, rl, prn)

A) The Shift button
B) The Backspace button
C) The Control button
D) The Caps Lock button
E) I don't know

28. How many targets do you get a chance to hit during your rifle marksmanship qualification? (e, rl, grp)

A) 20
B) 30
C) 40
D) 50
E) I don't know

29. When you are looking down the gun sites and pull the trigger, what direction does the aiming point of the gun move (kick)? (e, rl, grp)

A) Up
B) Up and Right
C) Up and Left
D) Left
E) I don't know

30. What gun do you use during your basic rifle marksmanship training and qualification? (f, ir, mul)

A) M60
B) AR-15
C) M16A2
D) AR-249
E) I don't know

31. When looking down the gun sites, what direction does the gun primarily sway in coordination with your breathing? (e, rl, grp)

A) primarily up then down
B) primarily up and right, then down and left
C) primarily up and left, then down and right
D) primarily left then right
E) I don't know

32. What is the nickname for Fort Benning? (f, ir, prn)

A) "Home of the Brave"
B) "Home of the Infantry"
C) "Land of the Courageous"
D) "Where Freedom Rings True"
E) I don't know

33. During basic rifle marksmanship qualifying, how many targets must you hit to qualify to attend sniper school? (f, rl, prn)

A) 23
B) 27
C) 32
D) 36
E) I don't know

34. At the start of basic rifle marksmanship qualification, where do you go to get your gun and ammo? (p, rl, mul)

A) Front and left
B) Front and right
C) Back and left
D) Back and right
E) I don't know

35. In the MOUT training, how do you select the "Flash/Bang" grenade? (p, rl, prn)

A) Press 3
B) Press 4
C) Press 5
D) Click Right mouse
E) I don't know

Instructions: Please be specific when answering the questions.

1. What about the "America's Army" game would make you want to play the game again?

2. Which section of the basic combat training did you like the most, and why?

3. Which section of the basic combat training did you like the least, and why?

4. What did you learn from the "America's Army" game?

5. What would you change about the "America's Army" game